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ABSTRACT

This instructional modular unit with instructor's guide provides materials on important aspects of one of the major systems of the human body--the digestive system. Its purpose is to introduce the student to the structures and functions of the human digestive system--and the interrelationships of the two--and to familiarize the student with some of the terms and concepts necessary for an understanding of the digestive system. The modular unit is made up of several components: a pretest; four instructional modules with objectives, informative materials, and corresponding post-tests; optional activities for the students; and a glossary of terms used in the unit. Topics covered in the modules include an introduction to the digestive system, alimentary tract, accessory organs, and the utilization of food. The instructor's guide provides suggestions for effective use of the materials, including descriptions of each component, use of the components, scoring the post-tests, and answers to the post-tests. Three additional modules on the respiratory musculoskeletal, and circulatory systems are available separately (see Note). (YLB)

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Instructional Materials in Anatomy and Physiology
for Pennsylvania Health Occupations Programs

THE DIGESTIVE SYSTEM

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PREFACE

An understanding of basic human anatomy and physiology is essential to any person preparing to enter a health occupation. This instructional unit is designed to introduce you to the structures and functions of the human digestive system--and the interrelationships of the two--and to familiarize you with some of the terms and concepts necessary for an understanding of the digestive system.

This unit consists of a pretest; four modules with their optional activities and post-tests; and a glossary of terms.

Begin this modular unit by taking the brief pretest at the front of the booklet. The pretest is for your use only, to give you an idea of what is included in this unit, and to give you an indication of the areas within the unit to which you should pay special attention (perhaps by working on the optional activities). When you have completed the pretest, turn to the answers in the back (page 38) to check your own score. You will not be graded on the pretest.

Next, read through each of the modules (Introduction to the Digestive System, Alimentary Tract, Accessory Organs, and The Utilization of Food) and investigate any of the optional activities that may be helpful or interesting to you. The optional activities will help you learn more about some of the material presented.

At the end of this unit (page 35) is a glossary which provides you with brief definitions of many of the terms used in the modules.

Upon completion of each module, you should be able to demonstrate an understanding of the material presented, by your performance on the post-test. When you have finished a module and feel that you understand the information in that module, take the post-test that follows it. Write down your answers on ONE piece of paper and pass it in to your instructor, who will give you your grade.

PRETEST

1. Which of the following is a part of the digestive system?

   A. bones
   B. stomach
   C. blood
   D. diaphragm

2. The breakdown of food into substances which can be used by the body is called:

   A. digestion.
   B. contraction.
   C. elimination.
   D. metabolism.

3. Which of the following is a passageway for both food and air?

   A. lungs
   B. esophagus
   C. pharynx
   D. trachea

4. After passing through the esophagus, food empties into the

   _____.

5. The actual digestion and absorption of most of the food in the body is completed in what organ?

   _____

6. Incisors, canines, and molars are examples of which of the following?

A. bones
B. teeth
C. cells
D. enzymes

7. Which of the following organs produces insulin?

A. liver
B. appendix
C. pancreas
D. intestine

8. The mechanism which moves materials through the alimentary tract is:

A. osmosis.
B. phagocytosis.
C. peristalsis.
D. oxygenation.

9. The primary function of bile is to aid in the absorption of:

A. fats.
B. hormones.
C. glucose.
D. protein.

10. The major function of the absorption process is to:

A. remove metabolic wastes.
B. get nutrients into the bloodstream.
C. transfer nutrients to the stomach.
D. remove water from body cells.

INTRODUCTION TO THE DIGESTIVE SYSTEM

Goals

Upon completion of this module, you should be able to:

1. Identify the components of the digestive system.
2. Describe the structure of the digestive system.
3. Identify the functions of the digestive system.

Much of the activity of our daily lives centers around the continuous need to provide food for our body tissues. The food you eat is processed by your digestive system to give you the energy needed to live. In some ways, the digestive system is like a factory: in one door of the factory come the raw materials needed to make whatever the factory produces. Inside the factory, workers use these materials to make their products; and, eventually, out the other door of the factory come the waste materials that could not be used. Without the raw materials, however, all work in the factory would stop.

In the human body, cells are working all the time, growing and repairing themselves, producing heat and energy, and taking part in all the normal body functions. To do all this, the cells must be furnished with a constant supply of nutrients, or materials to work with. These are not available within the body but must be obtained from food, the raw materials supplied to the "factory."

Food is taken in at one end of the digestive system; then the "workers" break it down to make products--proteins, fats, and carbohydrates--that are usable to the rest of the body cells; and the waste materials--those parts of the food which are not usable--are eliminated through the other end of the system.

STRUCTURE OF THE DIGESTIVE SYSTEM

At one end of the system, which is like a long tube running through the body, is the mouth (where food is taken in); at the other end is the anus (where waste materials are eliminated). The digestive system is made up of two main components, the alimentary tract and the accessory organs. The organs of the alimentary tract make up the long tube. They are the oral cavity, pharynx, esophagus, stomach, and intestine, which includes the rectum and anal canal. Several accessory organs, while not strictly part of this tube, aid in the functions of the alimentary tract. These include the teeth, salivary glands, liver, gallbladder, and pancreas.

Figure 1, on the next page, shows the organization of the digestive system: the organs of the alimentary tract and the accessory organs. Each organ of the system makes a unique contribution to the functions of the system as a whole.

FUNCTIONS OF THE DIGESTIVE SYSTEM

The complex structures and actions of the digestive system fulfill three basic functions: digestion, absorption, and elimination. First is digestion, which is the process of breaking down food into substances that the body cells can use. Once the food is digested, it is ready to be absorbed. Absorption is the second function of the system. This is the process of getting the nutrient materials from inside the alimentary tract (where they are not yet available for use by the body) into the bloodstream, which will transport them to areas where they are either utilized or stored. Not everything is absorbed; some elements of food cannot be digested or utilized, and must be eliminated from the body. Elimination, getting rid of the food's unusable components, is the third function of the digestive system.

The walls of the alimentary tract from the esophagus down through the anal canal are made up of several layers that are the same throughout most of the system. Each layer has a different function. The innermost layer is a mucous membrane that lines the entire system; this membrane constantly produces mucus, a thick and sticky substance which coats the tract and helps to protect, moisten, and lubricate the entire system. The next layer is made up of connective tissue. It supports the mucous membrane and also contains some of the nerves that supply the digestive system. The rest of the nerves are contained in the third layer, which is a double layer of muscle tissue. Most of this muscle is smooth (involuntary) muscle, except in the mouth, pharynx, and esophagus. The outermost layer of the tract organs is tough connective tissue which serves to keep the shape of the system, to anchor or suspend each organ in its proper place, and to protect it from tearing or rupture.

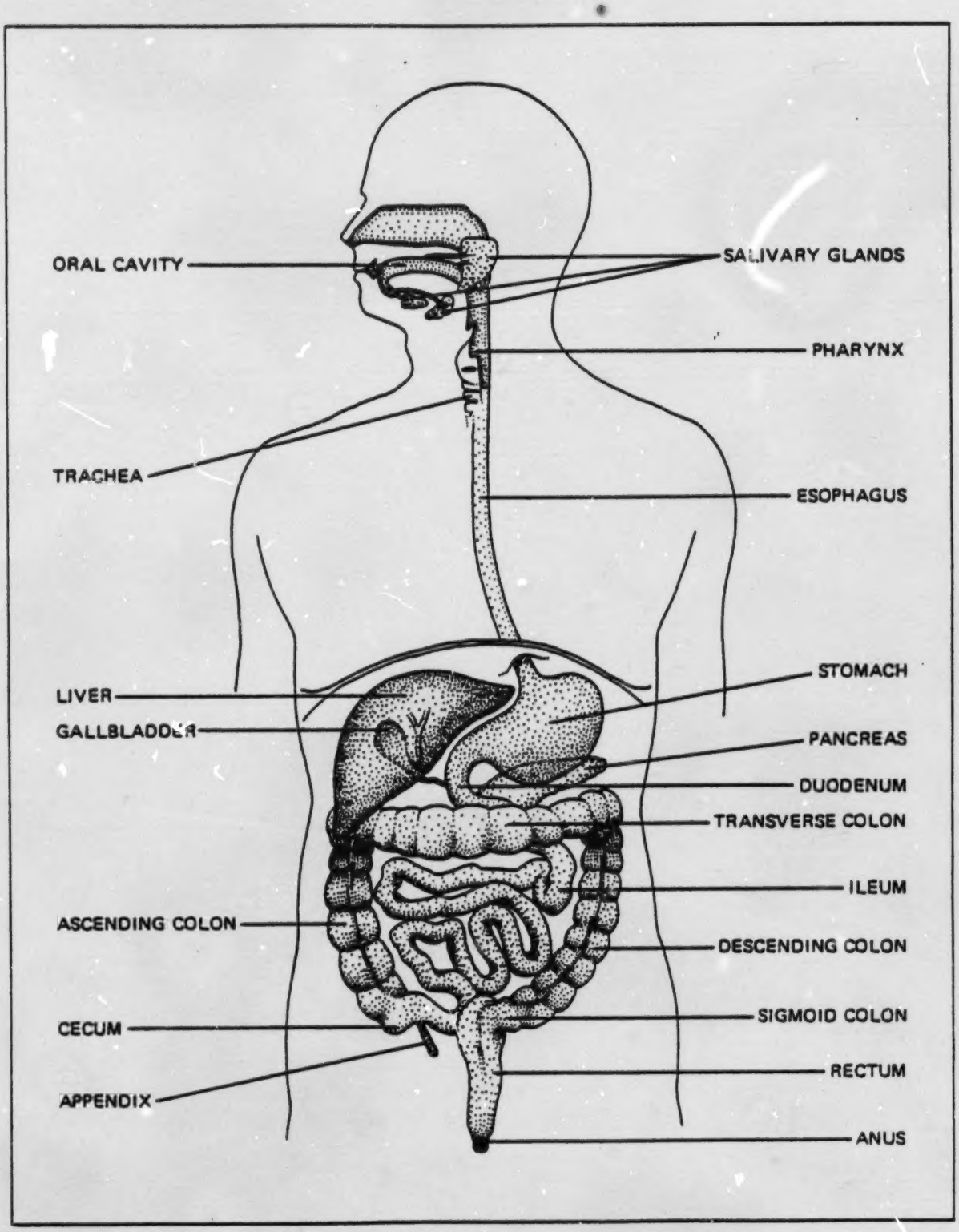


Figure 1. The Digestive System

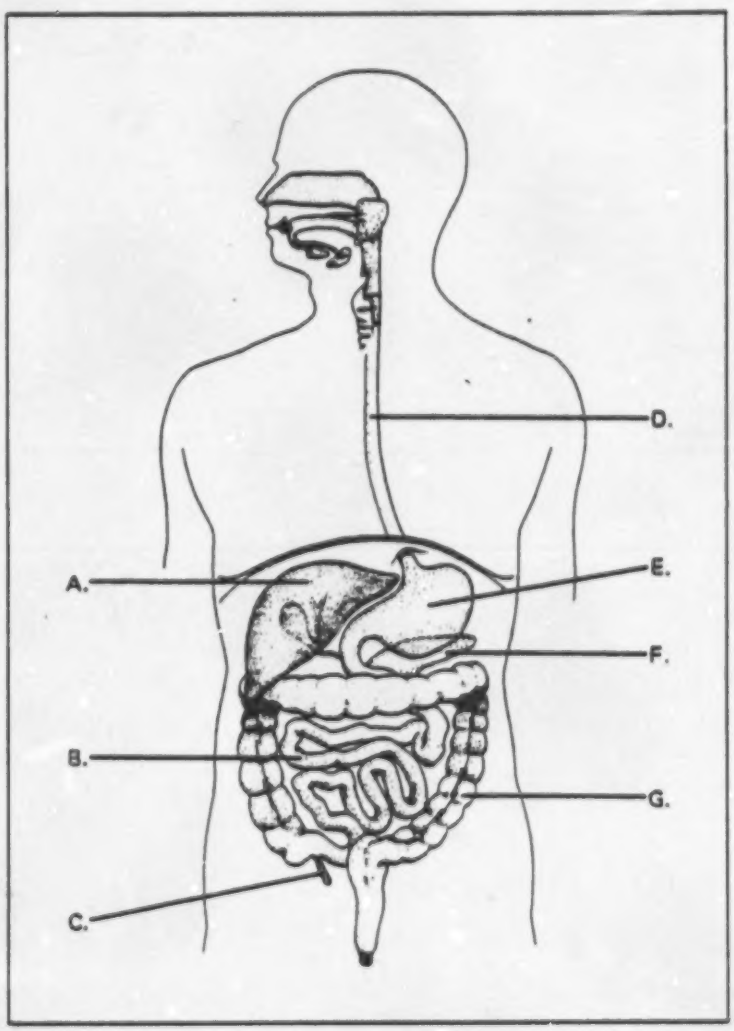
Optional Activities

- View a film or filmstrip on the human digestive system.
- Find out about intravenous feeding and how it compares to the functions of the digestive system.

INTRODUCTION TO THE DIGESTIVE SYSTEM

Post-Test

1. Match the parts of the digestive system (A-G) to their names below by putting the correct letter on the line in front of the name. (One of the letters will not be used.)



____small intestine

____stomach

____appendix

____esophagus

____liver

____large intestine

2. Food is first taken into the body through the

_____.

3. The two major divisions of the digestive system are the:

A. stomach and large intestine.
B. alimentary tract and accessory organs.
C. liver and gallbladder.
D. ascending colon and descending colon.

4. The innermost tissue layer of the alimentary tract is:

A. connective tissue.
B. mesentery.
C. muscle.
D. mucous membrane.

5. The process by which the bloodstream receives nutrients from the alimentary tract is called:

A. ingestion.
B. catabolism.
C. absorption.
D. conduction.

6. What are the three main functions of the digestive system?

_____

_____

_____

ALIMENTARY TRACT

Goals

Upon completion of this module, you should be able to:

1. Identify the organs of the alimentary tract.
2. Describe the structures of the alimentary tract organs.
3. Identify and describe the functions of the alimentary tract.

As food travels through the alimentary tract, it passes through several different organs. Although all are parts of the "tube," each organ is quite distinct.

THE PHARYNX

Food enters the digestive system (ingestion) through the mouth, where it is ground up by the teeth and pushed by the tongue into the pharynx. This is a cavity or hollow structure, extending from behind the nose and mouth into the throat. It is quite muscular, which is important to its function: it pushes the food down from the oral cavity into the rest of the alimentary tract by the action of swallowing.

Actually, the pharynx serves as a link between two different systems: the nose and trachea of the respiratory system and the mouth and esophagus of the digestive system. Because both food and air travel through the same passage, materials intended for the digestive system could easily work their way into the respiratory system—with uncomfortable or dangerous results—were it not for a safeguarding device at the bottom of the pharynx. This device is the epiglottis, a flexible fold of cartilage often described as leaf-shaped. The epiglottis snaps down to seal off the respiratory passageways when food is swallowed; this action keeps food and fluids from "going down the wrong tube" by channeling them into the proper pathway.

THE ESOPHAGUS

The proper pathway for food is the esophagus. It is about 10 inches long in an adult, and extends down the neck behind the trachea to link the pharynx to the stomach. The esophagus is also muscular and can expand to accommodate a mass of swallowed food.

THE STOMACH

The main process of digestion begins with the organ connected to the end of the esophagus, the stomach. This is a bag-like, hollow organ, shaped like a comma (,). It is positioned beneath the left side of the diaphragm, partly shielded by the lower edge of the ribcage, with its tail curving toward the midline of the body. It is held in place in the abdomen by a layer of tough connective tissue, called mesentery, which also supports other organs of the alimentary tract. The stomach is constructed of the same layers as the rest of the tract, but it also has millions of gastric glands lying in the mucous membrane. These are clusters of cells which secrete gastric juice, a watery fluid containing hydrochloric acid and digestive enzymes. Gastric juice is necessary for the stomach to fulfill its major function: to initiate the digestion of food. When a mass of food passes into the stomach from the esophagus, the stomach releases large quantities of gastric juice into the mass. Then, by the action of its muscular layer, the stomach churns the food and juices around to break up and thoroughly mix the stomach contents. The resulting liquefied mass is stored in the stomach until it is ready to pass into the small intestine. The stomach can hold up to three pints of this material, which is called chyme.

THE SMALL INTESTINE

The small intestine connects to the end of the stomach and coils and curves through the abdomen. In structure it resembles a convoluted, or twisted, length of garden hose, about one and a half inches in diameter and about 12 feet long. The inner layer or mucous membrane of the small intestine is slightly different from the mucous membrane of the rest of the system; not only is it pleated and folded, but also it pouches out in millions of microscopic, finger-like extensions called villi.

The folds and villi, like the coils of the small intestine, are structural features that help this organ fulfill its function. Convolutions permit a long tube to be packed into a small space--in this case the abdomen; the pleats and folds of the inner layer of this tube add further to the inner surface area. The small intestine must have as much surface area as possible to function properly, because it is in this part of the alimentary tract that most of the digestion and absorption of food takes place. A vastly increased surface area (the small intestine contains about 100 square feet of absorptive surface) allows for more thorough digestion and absorption.

The small intestine has three sections. First is the duodenum, which is the section about a foot long that connects to the stomach. Next is the four-foot-long jejunum; then the ileum, which extends about seven feet before emptying into the large intestine.

THE LARGE INTESTINE

The large and small intestines join in a T-intersection. One bar of the "T" is a pouch called the cecum. From the cecum rises a small worm-like structure called the appendix, which is interesting because it has no known function. The opposite bar of the "T" leads to the rest of the large intestine, so called because its two-and-a-half-inch diameter is greater than that of the small intestine. From the point where it joins the ileum, the large intestine ascends up the right side of the abdomen (ascending colon), crosses over (transverse colon), descends down the left side (descending colon), then returns to the central lower abdomen where the sigmoid colon leads into the rectum and the muscular anal canal. The anal canal is the last portion of the digestive system. From cecum to anal canal, the large intestine is about five feet long.

Unlike the small intestine, the large intestine has no villi, but it does have a great number of mucous cells. This is because the functions of the two intestines are different: the large intestine does not contribute to digestion at all, since almost all usable materials have already been absorbed by the small intestine. Instead, the large intestine absorbs water from the mass of unusable material; this process compacts the material into feces, which the large intestine then stores until enough material has collected to cause its elimination from the body. The feces, waste material left over from the food introduced into the system through the mouth, passes down the rectum, through the anal canal, and out of the body through the anus.

Optional Activities

- Take apart an anatomical model to see exactly how the organs of the digestive system fit together and how they fit into the body.
- Examine cross-section slides of the stomach and intestines to try to identify the special features of the layers (for example, the villi).
- On a model or anatomical chart of the body's main organs, identify the organs of the digestive system.
- Find out what scientists think about why we have an appendix.

ALIMENTARY TRACT

Post-Test

1. The function of the appendix is:

   A. absorption.
   B. phagocytosis.
   C. digestion.
   D. unknown.

2. In swallowing, the tongue pushes food from the oral cavity into the _____.

3. The fold of cartilage which prevents food from entering the lungs is called the:

   A. esophagus.
   B. epiglottis.
   C. trachea.
   D. colon.

4. Food entering the body is ground up in which area?

   A. oral cavity
   B. pharynx
   C. esophagus
   D. larynx

5. The esophagus has the ability to:

A. produce digestive enzymes.
B. expand to accommodate food.
C. transport oxygen to the lungs.
D. transmit nerve impulses.

6. Which of the following is found in the oral cavity?

A. glottis
B. appendix
C. villi
D. tongue

7. Which of the following is secreted by the stomach?

A. hormones
B. glycogen
C. insulin
D. gastric juice

8. The stomach is held in place in the abdomen by the:

A. cecum.
B. lungs.
C. mesentery.
D. ribs.

9. Which of the following best describes the appearance of the stomach?

A. a tube approximately 1½ inches in diameter
B. a bag-like, hollow structure
C. a round, solid organ
D. a small, red, oval organ

10. When food reaches the stomach it is mixed with digestive juices to form a liquid mass. This mass is called:

A. chyme.
B. gastric juice.
C. mucus.
D. hydrochloric acid.

11. The stomach churns food and juices together to:

A. prevent indigestion.
B. complete digestion.
C. mix them thoroughly.
D. produce enzymes.

12. The finger-like extensions on the inner surface of the small intestine are called

_____.

13. The main purpose of the many folds on the interior of the small intestine is to:

A. increase the surface area for absorption.
B. slow down the rate at which food passes through.
C. produce bile and digestive enzymes.
D. allow for the tube to expand.

14. What are the three sections of the small intestine?

_____

_____

_____

15. The last portion of the digestive tract is the:

A. stomach.
B. cecum.
C. anal canal.
D. descending colon.

16. Which of the following is absorbed in the large intestine?

A. protein
B. fats
C. carbohydrates
D. water

17. Solid wastes are compacted and stored temporarily in the

_____.

18. The pouch of the large intestine that the appendix arises from is the:

A. ileum.
B. cecum.
C. transverse colon.
D. rectum.

ACCESSORY ORGANS

Goals

Upon completion of this module, you should be able to:

1. Identify the accessory organs of the digestive system.
2. Describe the structures of the accessory organs of the digestive system.
3. Identify and describe the functions of the digestive accessory organs.

Several organs of the body that are not part of the alimentary tract also contribute to the digestive process. These are the digestive accessory organs. Some of these accessory organs are located in the mouth. They assist in ingestion, the first step necessary for the digestive process. In the lower part of the tract are accessory organs that produce secretions or fluids which empty into the gastrointestinal system (stomach and intestines) through small tubes or ducts. These fluids are vital to digestion.

ORAL CAVITY

Accessory organs located in the mouth or oral cavity and throat are the tongue, teeth, and salivary glands. Anchored to the bottom of the mouth, the tongue has a rough surface and is very muscular, aspects of its structure that make it efficient in manipulating food within the mouth. The tongue pushes food to the teeth to be chewed and then propels it back to the pharynx to be swallowed.

The teeth are responsible for breaking down food into small pieces which can then be sent through the esophagus into the stomach. They are rooted into the jaws and further secured by the gums (which are part of the mucous membranes of the oral cavity). The visible part of a tooth, the crown, is coated with a substance called enamel. Enamel is even harder than bone; this helps it withstand the constant grinding of tooth on tooth that occurs in chewing. Chewing, of course, is the main function of teeth.

Different types of teeth are structured to perform the different types of chewing necessary to break down the many kinds of food that we ingest. Incisors, those teeth at the front of the mouth, are shaped to cut into food by biting. The canine teeth beside the incisors are ideal for tearing off food that is difficult to bite. Bicuspid and tricuspid molars, the teeth farther back along the jaw, have larger surface areas suitable for grinding of food; the most thorough chewing is done with these teeth.

As the food in the mouth is ground into smaller particles, it is mixed with an acidic watery fluid called saliva. This fluid binds and moistens the ground food, making it easier to swallow. Saliva also contributes to the digestive process because it contains a digestive enzyme that breaks down carbohydrates. Thus, to a small extent, food entering the stomach has been digested by the action of the saliva.

Three salivary glands secrete this fluid. The sublingual gland lies under the tongue and produces the mucus component of saliva. Below and slightly to the rear of the sublingual gland is the submandibular gland, which produces salivary fluid and digestive enzymes. Located at the sides of the jaws just in front of the ears are the parotid glands, largest of the salivary glands, which produce all three components of saliva. These glands connect to the oral cavity by way of small ducts, all of which secrete saliva into the mouth.

Food moving from the pharynx through the digestive system is not affected by the action of accessory organs again until it reaches the small intestine. In the lower part of the alimentary tract, the liver, gallbladder, and pancreas become important to the process of digestion.

GALLBLADDER

The gallbladder is a small sac attached to and lying beneath the liver. It stores and concentrates bile, a substance produced by the liver and necessary to the absorption of fats. Bile drains into the gallbladder through ducts; the gallbladder stores it until food moves into the small intestine, at which time the gallbladder sends bile into the intestine by way of the common bile duct.

LIVER

Bile is only one of the substances produced by the liver, the largest gland in the body. The liver is indeed large: it weighs three to four pounds in an adult. It

lies against the diaphragm in the upper right area of the abdomen, reaching well up under the ribs; its lower edge extends just below the bottom edge of the right ribcage. The liver is divided into lobes and anchored to the diaphragm and abdominal wall by tough ligaments. There are two major lobes, the left lobe and the larger right lobe, which is further divided into two minor lobes. The right and left hepatic ducts are tubes which drain the lobes of bile and join to become the common bile duct, which leads from the liver and the gallbladder to the small intestine.

The liver serves a number of functions, among them the storage and filtering of blood and the recycling of components of red blood cells. Its functions within the gastrointestinal system involve production of digestive secretions, mainly bile, and storage of digested nutrients. It also helps remove harmful substances from the blood through a process called detoxification (removing poisons). Materials processed by the liver are brought into the organ by way of the hepatic portal system. Capillaries lining the small intestine drain into the portal vein, which then drains into a network of blood vessels--the hepatic system--in the liver. Blood passing through this system, having absorbed the products of digestion, is loaded with nutrients. Some of these (especially sugars and vitamins) are converted into storable form and held by the liver until needed by the body.

PANCREAS

Like the liver, the pancreas is a gland linked to the alimentary tract by ducts. It is much smaller than the liver (it weighs only about three ounces) and lies in the back of the upper right abdomen behind the stomach. The pancreas is essential to digestion because it produces quantities of digestive enzymes which form the pancreatic juice. This juice drains into the small intestine where, together with intestinal enzymes, it is responsible for the major digestive action of the small intestine.

Another function of the pancreas is to produce hormones which determine the liver's rate of sugar (glucose) storage and affect the body's utilization of some of the products of digestion. The best-known of these hormones is insulin, which determines the amount of glucose available in the blood for use by the body's cells.

Figure 2, on the next page, shows the structures of the accessory organs of the digestive system.

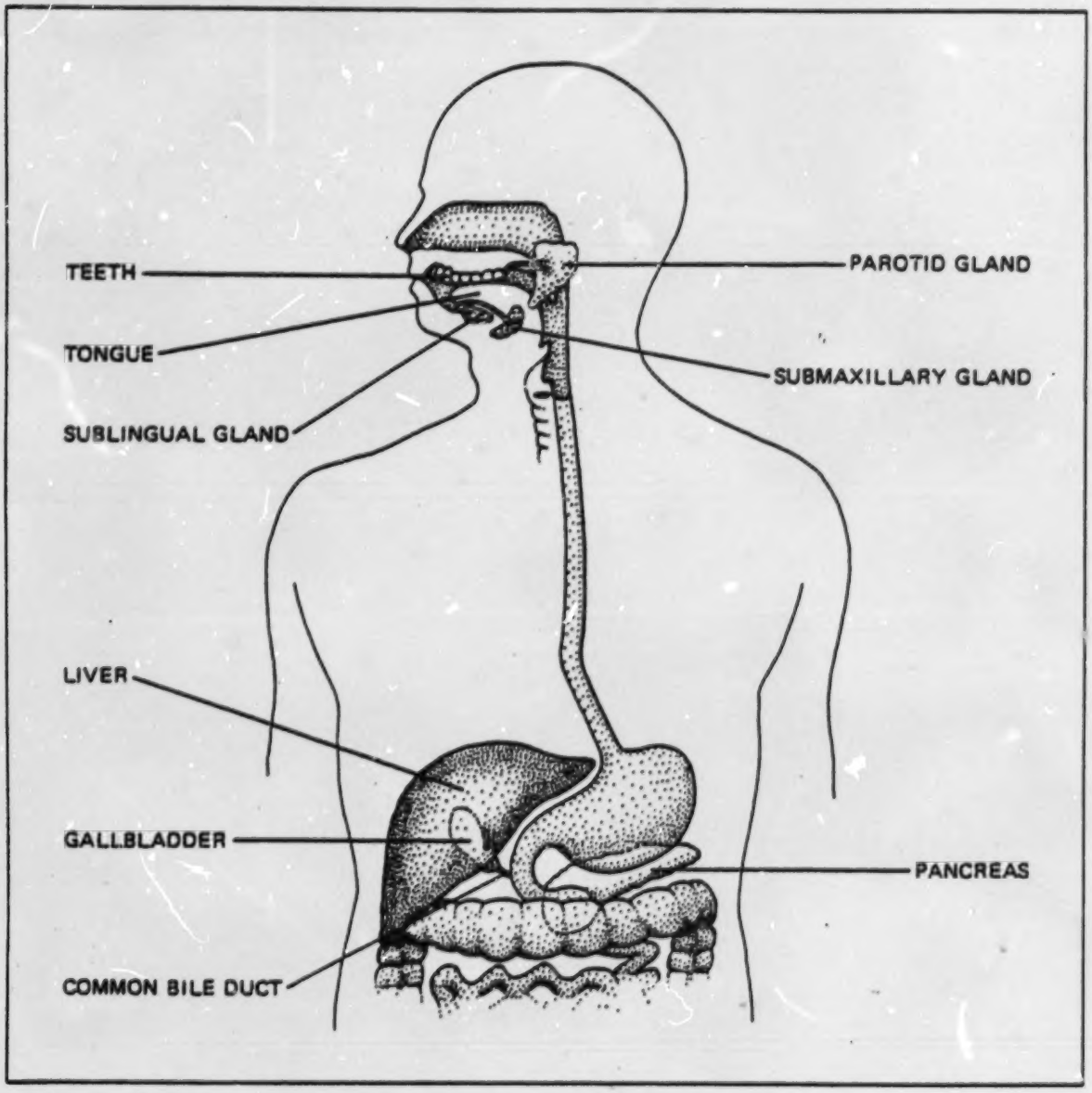


Figure 2. The Digestive Accessory Organs

Optional Activities

- Examine a whole calf's liver for lobes, ducts, and ligaments.
- Examine a model of human teeth. Try, just by looking at them, to figure out what type of chewing they are structured to perform.
- Find out what kinds of food stimulate more saliva than others, and why.
- Find out what gallstones are and how they form.
- Find out about the role of insulin in diabetes.

ACCESSORY ORGANS

Post-Test

1. Which of the following is an accessory organ of the digestive system?

   A. salivary gland
   B. thymus
   C. kidney
   D. pituitary gland

2. The largest gland in the body is the:

   A. parotid gland.
   B. stomach.
   C. liver.
   D. thyroid gland.

3. The pancreas is a:

   A. part of the alimentary tract.
   B. digestive accessory organ.
   C. type of protein.
   D. producer of vitamins.

4. The small organ that is attached to the liver is the:

   A. epiglottis.
   B. cerebellum.
   C. parotid gland.
   D. gallbladder.

5. The liver is divided into major sections which are called

_____ _____.

6. Saliva contains an enzyme which breaks down:

A. protein.
B. fat.
C. vitamins.
D. carbohydrates.

7. The gallbladder stores which of the following?

A. bile
B. pancreatic juice
C. hydrochloric acid
D. gastric juice

8. The organ capable of detoxifying poisonous substances in the bloodstream is the

_____.

9. Name the three pairs of salivary glands.

_____

_____

_____

10. The tube that transports digestive juices from the liver and gallbladder to the small intestine is the:

A. esophagus.
B. common bile duct.
C. hepatic portal system.
D. pancreatic duct.

THE UTILIZATION OF FOOD

Goals

Upon completion of this module, you should be able to:

1. Identify and describe the processes of mechanical digestion.
2. Identify and describe the processes of chemical digestion.
3. Describe the processes of absorption and metabolism.

As you learned earlier, the purpose of the digestive system is to make the necessary nutrients available for use by the body's cells. In order to convert food into the materials that can be used in the processes of metabolism, the sum of all chemical reactions in the body, the digestive system must reduce the food to its essential components. This task is accomplished by two different methods of digestion, mechanical and chemical.

MECHANICAL DIGESTION

Mechanical digestion is the process of physically breaking down food from its original form into pieces that are small enough to be digested chemically, and the process of moving these materials through the alimentary tract. Mechanical digestion begins in the process of ingestion with the first bite and the chewing that follows. Chewing is the most efficient form of mechanical digestion, as it rapidly and thoroughly breaks food into very small pieces; in this way chewing makes the food accessible to the digestive action of the saliva, and small enough to pass through the esophagus. The next step in mechanical digestion is swallowing, which compacts the food into a bolus or mass of food, and regulates the amount of food that enters the stomach at one time.

The bolus travels through the esophagus, propelled by a series of muscular contractions called peristalsis: the tract squeezes the food toward the stomach and through the rest of the alimentary tract by alternately relaxing and contracting to force the bolus through the system. Peristalsis is the mechanism that moves food through the system for digestion, and is responsible for the churning action of the stomach which breaks apart food masses and mixes them with gastric juice. Peristalsis is accomplished by contractions of the smooth muscle layer of the alimentary tract; it occurs from the esophagus to the anal canal. Peristalsis is also partially responsible for defecation, the elimination of solid waste matter from the body.

CHEMICAL DIGESTION

Mechanical digestion prepares the food for the major digestive process, which is chemical. Different chemical substances in the stomach and small intestine help to digest each of the necessary nutrients (proteins, carbohydrates, and fats). The stomach is responsible for the initial digestion of proteins; hydrochloric acid produced and secreted in the stomach begins splitting protein molecules. Large chunks and molecules of proteins are chemically split in the stomach into small chains of amino acids. (Amino acids are the basic building blocks of proteins.) The stomach walls, which like most tissues in the body are made of protein, have to be protected from being digested by the protein-splitting enzymes produced in the stomach. This function is served by the mucous membrane lining, which not only coats the inner walls of the stomach with a protective covering of mucus, but also neutralizes the acid near those walls, rendering the enzymes ineffective at the wall surface.

In the small intestine, both pancreatic juice and intestinal juice help to complete the digestion of protein. The now small chains of amino acids are split into individual amino acids, which can then be used as needed by the body's cells. Intestinal and pancreatic juices also help digest carbohydrates and fats. Carbohydrates, which are made up of complex sugars, are broken down to some extent in the stomach. The remaining carbohydrates are split into complex sugars by the pancreatic juice, and then split into simple sugars (the basic building blocks of carbohydrates) by intestinal enzymes. These simple sugars are the units used by the cells.

Fats, which are made up of large molecules, are broken into their basic units by pancreatic juice in the small intestine. Fats tend to clump together, and are somewhat difficult for the enzymes to digest. Bile, however, separates the clumps of fat molecules, making it easier for the appropriate enzymes to act on the fat molecules. Fats can then be broken down into their basic building blocks, fatty acids.

ABSORPTION

Absorption is the last step necessary to making nutrients available for cellular utilization. Nutrients must be transported to the cells by the bloodstream; absorption is the process by which nutrients enter the blood. The end products of digestion are simple and small enough to pass through—or be actively carried through—the walls of the gastrointestinal tract and blood vessels into the bloodstream. Little absorption occurs in the stomach because at this early stage of digestion the nutrients are not yet broken down into absorbable units; only water and some simple sugars are absorbed in the stomach.

The major absorption of nutrients occurs in the small intestine, which is also where most of the digestion takes place and where the end results of digestion, the basic building blocks needed by the cells, are produced. Absorption in this area of the gastrointestinal tract takes place through the greatly increased surface area provided by the villi. The small intestine leaves little to be absorbed, and what it leaves is mostly fluid waste. The large intestine, with only this material to work with and with no villi, absorbs water to compact the waste. Simple sugars, amino acids, and fatty acids pass through the thin walls of the villi and into the blood stream through the walls of the capillaries which are arranged in a dense network around the outside of the intestinal walls.

USE OF NUTRIENTS

Once in the bloodstream, the nutrients have undergone the complete digestive process and are available for use by the body cells. The cells utilize the nutrients in their normal metabolic processes, or the processes of releasing and consuming energy, growing and repairing tissue, and fulfilling their own special functions within the body. The processes that produce energy use fatty acids and simple sugars as "fuel." Amino acids are sometimes converted into molecules which can be used to fuel the energy-producing cycles. However, amino acids are primarily used by cells for tissue growth and repair. Amino acids combine to manufacture proteins required by the body to form enzymes, tissues, hemoglobin, and other necessary substances and structures within the body.

Protein is the basic structural unit of the body, accounting for almost one-fifth of total body weight. Fats and carbohydrates are the fuels of the body which provide the energy to support life. These materials cannot be utilized in their original form but must be broken down and converted into forms that the body's cells can use. Thus the digestive system takes foodstuffs into the body, breaks them down into components the body can use, transports them into the bloodstream, and eliminates materials which are not usable.

Optional Activities

- Invite a nutritionist to lecture on the topic of balancing a diet to include the proper proportions of proteins, fats, and carbohydrates for optimum energy production and tissue growth and repair.
- To visualize how bile acts on fat within the small intestine, try to dissolve a lump of soft butter in water without the action of any other substance. Then add detergent, which acts on fat in much the same way that bile acts on fat, and see what happens.
- Compare the absorptive capabilities of a linen towel and a terrycloth towel to see the difference made by the intestinal villi.
- If you can obtain some solutions of digestive enzymes, compare the length and effectiveness of chemical digestion with and without the aid of mechanical digestion. Place different kinds of food, chopped and left whole, into the enzymes, and compare the results.
- Compare the mechanism of peristalsis to the motion of blood flow through the body.
- Try to complete the word maze on the following page. It uses some of the terms that you learned in this unit.

WORD MAZE

M	S	Y	N	X	B	W	P	A	N	C	R	E	A	S	R
B	O	A	B	S	O	R	P	T	I	O	N	N	O	S	A
I	L	P	E	R	I	S	T	A	X	N	S	G	V	E	R
L	I	N	O	I	T	S	E	G	N	I	A	M	O	T	S
M	U	C	R	K	R	P	O	C	S	T	I	O	N	V	R
U	M	R	Y	S	T	W	H	L	H	T	A	Y	P	R	E
T	U	E	N	O	C	H	A	I	N	G	O	U	Z	I	C
C	S	A	O	M	Y	T	I	V	A	C	K	M	L	M	Q
E	N	S	B	A	S	J	V	E	U	D	I	X	A	U	U
R	P	P	E	I	M	S	I	R	C	I	R	E	P	C	H
D	Z	O	R	N	L	E	K	C	J	S	D	O	N	U	H
O	C	E	H	U	G	E	A	S	U	L	O	B	E	S	O
G	P	Q	I	C	R	B	R	F	S	P	J	A	K	N	R
M	O	A	P	P	E	N	D	I	X	N	Y	R	A	H	P
U	R	R	E	R	E	G	W	O	L	D	U	L	D	Y	B
W	I	D	R	T	V	L	E	V	I	L	L	I	N	K	S

Find the following terms in this maze by circling the words. They may appear frontwards or backwards, vertically, horizontally, or diagonally.

absorption
appendix
bile
bolus
ingestion
liver
mucus
pancreas
peristalsis
pharynx
rectum
stomach
villi

THE UTILIZATION OF FOOD

Post-Test

1. What are the two main types of digestion?

   _____

   _____

2. A bolus is a:

   A. blockage of the common bile duct.
   B. small mass of food.
   C. building block of proteins.
   D. nutrient necessary to body cells.

3. Which of the following is an important element of mechanical digestion?

   A. chewing
   B. splitting of proteins
   C. secretion of bile
   D. absorption

4. The elimination of solid waste matter from the alimentary tract is called:

   A. digestion.
   B. absorption.
   C. metabolism.
   D. defecation.

5. The wave-like contractions that move materials through the digestive system are part of the process of

_____.

6. Where does peristalsis occur?

A. from the liver to the gallbladder
B. only in the oral cavity
C. from the esophagus to the anus
D. only in the stomach

7. Within the alimentary tract, proteins are broken down into:

A. vitamins.
B. water and potassium.
C. digestive enzymes.
D. amino acids.

8. Simple sugars are the building blocks of what food group?

_____

9. Hydrochloric acid is produced and secreted by what digestive organ?

_____

10. What are the basic building blocks of fats?

_____

11. The chemical splitting of proteins begins in the:

A. mouth.
B. pharynx.
C. esophagus.
D. stomach.

12. Nutrients are absorbed in the small intestine by the:

A. smooth muscle.
B. appendix.
C. villi.
D. mesentery.

13. The sum of all of the chemical reactions in the body is called _____.

14. The basic fuels for cell functioning are:

A. proteins and lipids.
B. fats and enzymes.
C. carbohydrates and hormones.
D. fats and carbohydrates.

15. The body uses amino acids primarily for:

A. tissue growth and repair.
B. fighting disease.
C. transporting oxygen in the blood.
D. initiating digestion.

16. The stomach is capable of absorbing:

A. all basic nutrients.
B. fiber and carbohydrates.
C. only proteins and amino acids.
D. only simple sugars and water.

GLOSSARY

absorption: the process of transporting nutrients from the digestive tract to the bloodstream.
accessory organs: organs which aid in the digestive process but are not part of the alimentary tract.
alimentary tract: the system of tubes through which food passes; the mouth, esophagus, stomach, intestines, and anus.
amino acids: the basic building blocks of proteins.
anal canal: the last portion of the alimentary tract.
appendix: an appendage of the large intestine, function unknown.
ascending colon: a portion of the large intestine.

bile: a fluid secreted by the liver which breaks down fats.
bolus: a mass of food.

canine teeth: teeth designed for tearing.
cecum: the area of the large intestine where it joins the small intestine.
chyme: liquid mass of food and digestive enzymes.

defecation: the process of removing solid wastes from the body.
descending colon: a portion of the large intestine.
detoxify: to remove poisonous substances from.
digestive enzymes: substances which help break down foods into more basic substances.
duodenum: the first portion of the small intestine.

enamel: the hard outer covering of a tooth.
epiglottis: a fold of cartilage which guards the opening of the trachea.
esophagus: the portion of the alimentary tract which extends from the pharynx to the stomach.

fatty acids: the basic building blocks of fat molecules.
feces: solid waste matter.

gallbladder: a digestive accessory organ which stores and concentrates bile.
gastric: of the stomach.

hepatic duct: a duct leading from the liver and joining the common bile duct.
hydrochloric acid: a powerful acid secreted by the stomach.

incisors: teeth in the front of the mouth.
ingestion: the act of taking food into the body.
insulin: a hormone produced in the pancreas.
intestine: the largest part of the alimentary tract; includes the large and small intestines; responsible for digestion, absorption, and elemination of wastes.

jejunum: the second portion of the small intestine.

liver: a digestive accessory organ; the largest gland in the body.
lobes: divisions of the liver.

mesentery: a fold of tissue that suspends the digestive organs from the abdominal wall.
metabolism: the sum of all the chemical reactions within the body.
molars: the rear teeth.
mucous membrane: the inner lining of the alimentary tract.
mucus: a thick fluid secreted by mucous membranes.

oral cavity: the interior of the mouth.

pancreas: a digestive accessory organ; manufactures pancreatic juice and insulin.
parotid gland: the uppermost salivary gland.
peristalsis: the wave-like motion which propels materials through the alimentary tract.
pharynx: the cavity behind the mouth, responsible for the act of swallowing.

rectum: part of the large intestine, directly preceding the anal canal.

saliva: a fluid secreted into the mouth by the salivary glands, capable of digesting carbohydrates.
salivary glands: three pairs of glands which secrete saliva; digestive accessory organs.
stomach: a bag-like structure responsible for initiating digestion.
sublingual gland: one of the salivary glands.
submandibular gland: one of the salivary glands.

transverse colon: a portion of the large intestine.

villus (pl. villi): a finger-like projection from the mucous membrane of the small intestine through which most of the absorption of nutrients takes place.

ANSWERS TO THE PRETEST

Question	Correct Response
1	B
2	A
3	C
4	stomach
5	small intestine
6	B
7	C
8	C
9	A
10	B

HEALTH OCCUPATIONS EDUCATION MODULE

VF 035 765

INSTRUCTOR'S GUIDE
THE DIGESTIVE SYSTEM

Instructional Materials in Anatomy and Physiology
for Pennsylvania Health Occupations Programs

INSTRUCTOR'S GUIDE:

THE DIGESTIVE SYSTEM

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INTRODUCTION

These instructional modular units have been developed for the Pennsylvania Department of Education for use in vocational education programs. They were designed on the assumption that a basic understanding of human anatomy and physiology is essential to any person preparing to enter a health care occupation such as practical nursing, nursing assistant, medical assistant, emergency medical technician, or dental assistant. Each of these modular units will cover the most important aspects of one of the major systems of the human body. In the first four units the following systems will be covered: circulatory system, respiratory system, musculoskeletal system, and digestive system.

This Instructor's Guide is designed to provide suggestions to you on how to use a modular unit most effectively in your instruction. These recommendations, however, do not represent the only way to use these units: you may be able to devise more beneficial uses for the materials.

THE MODULAR UNITS

Each modular unit is made up of several components: a pretest, four to seven instructional modules with corresponding post-tests, optional activities for the students, and a glossary of terms used in the unit. Each of these components has a specific purpose and is organized in a specific way, as will be explained in the following sections.

Pretest

After reading the preface, which is simply an introduction to these instructional units, a student working through a modular unit should first take the pretest. As its name implies, this test is designed to be taken by the student before beginning work on the materials contained in the unit. Its purpose is twofold: (1) to stimulate interest in the modular unit by giving the student a preview of the topics covered, and (2) to provide a means of self-diagnosis so the student may identify, based on performance on the pretest, those areas of the

modular unit which may require special attention and extra effort on the part of the student. After selecting an answer to each of the pretest questions, the student should turn to the back of the modular unit and check the correct answers. If the student answers incorrectly on a number of questions dealing with a particular subject, then the student should pay closer attention to the module on that subject.

Instructional Modules

This modular unit is composed of four separate but closely related modules, including: Introduction to the Digestive System, Alimentary Tract, Accessory Organs, and The Utilization of Food. After taking the pretest and checking the answers, the student should read through and study each of the instructional modules. For the student's benefit, each module begins with a statement of the goals, or objectives, that a student should have mastered upon completion of that particular module. The level of achievement of these goals is measured by the student's performance on the corresponding post-test. The language level and content of each module is aimed toward the student seeking an introduction to the components, structures, and functions and the basic terminology required for an understanding of the digestive system.

Optional Activities

Following many modules are optional activities intended to provide the student with an opportunity to pursue the content of the module at a more in-depth level. Many of these activities may require teacher participation, at least in obtaining and preparing additional materials for the student to utilize.

In addition to the optional activities available to the students, you may choose to provide further information to the students by teaching a brief unit on the common disorders of the digestive system. Discussion of these disorders has not been included in the texts because a basic knowledge of the proper structure and function of the human body in a healthy individual seems more appropriate for the purposes of an introductory program. If you do choose to discuss common disorders, the most effective approach may be one in which you use disorders to illustrate what can go wrong in the body, as a means of clarifying the students' understanding of how the body works when functioning properly.

You may also wish to provide students with the names of books or articles as suggested readings to further their understanding of a particular area.

Glossary

After the last of the modules in the unit is a glossary. This is not intended to be a comprehensive glossary to be used by the student as a dictionary. Rather, it includes the basic terms used in the unit which are necessary to an understanding of the system covered. Those words which appear in the modules and have been defined in the text are not always defined in the glossary. Some of these particular terms have been used in the module because they are essential but difficult terms needed to explain the content taught in the unit. The student should use the glossary to review the vocabulary essential to the unit before taking the post-tests.

Post-Tests

The post-tests are the final assessment of a student's understanding of the material presented in each module. They consist of multiple-choice and open-ended questions designed to measure a student's mastery of the goals (objectives) stated at the beginning of each module. Each of the questions has been written to measure an aspect of the skills and/or knowledge that a student may be expected to acquire as a result of working through a particular module. When a student has finished studying a module, has pursued any chosen optional activities, and has reviewed the vocabulary in the glossary, the student should take the post-test that follows the module.

SCORING THE POST-TESTS

As previously mentioned, the purpose of the post-tests is to measure whether or not a student has mastered the objectives (goals) stated at the beginning of each module. Due to the differing lengths of the post-tests, the variety of ways in which teachers may choose to utilize these modules, and discrepancies among students' previous exposure to the subject matter, it is not practical to set a standard cut-off score on each of the tests that would indicate mastery of the objectives. Rather, teachers are asked to use their professional judgment in individual cases to determine if a student's performance on a post-test indicates that he or she has mastered the objectives stated for that module. In making this determination, you should consider at least all of the following factors:

(1) How long is each post-test?

(2) How much information is included in each module and how complex is the information, relative to other modules?

(3) Has the student been exposed to the kind of curricular material before? That is, has the student been taught the basics of this system of the body before?

(4) Should the entire class be required to achieve a certain score in order to pass, or should each student be considered individually? (This depends on how and with whom you use this module as instructional material.)

(5) Should the student be graded pass/fail on each post-test--i.e., on mastery of each module--or on the unit as a whole?

To facilitate the scoring of post-tests, each student will record his or her answers to all the post-tests on one separate sheet of paper. You should mark each answer correct or incorrect, then give the student a "pass" or "fail" on each module, or on the unit as a whole.

Because of the subject matter, responses to open-ended questions may vary slightly from those listed below, but these responses may also be acceptable. Again, in these cases instructors are asked to use their professional judgment to determine if a response is correct.

Use the following list of answers to questions on the post-tests to grade your students' papers.

ANSWERS TO THE DIGESTIVE SYSTEM POST-TESTS

Module/Question	Correct Response
Introduction to the Digestive System:	
1	B -- small intestine E -- stomach C -- appendix D -- esophagus A -- liver G -- large intestine
2	mouth (oral cavity)
3	B
4	D
5	C
6	digestion, absorption, elimination
Alimentary Tract:	
1	D
2	pharynx
3	B
4	A
5	B
6	D
7	D
8	C
9	B
10	A
11	C
12	villi
13	A
14	duodenum, jejunum, ileum
15	C
16	D
17	large intestine
18	B

Module/Question	Correct Response
Accessory Organs:	
1	A
2	C
3	B
4	D
5	lobes
6	D
7	A
8	liver
9	parotid, sublingual, submaxillary
10	B
The Utilization of Food:	
1	chemical, mechanical
2	B
3	A
4	D
5	mechanical digestion
6	C
7	D
8	carbohydrates
9	stomach
10	fatty acids
11	D
12	C
13	metabolism
14	D
15	A
16	D